$\mu_{4}(s)$, continuity of, 114, 129–31 Activities, economy of. See Economy of activities Adaptive expectations, 65, 67 Adjustment process, 67, 68, 96, 102 Admissible endowment set, 154 Admissible price vectors, 193, 221 Allocation competitive, 174 in core, 174-75, 181 feasible, 166, 171, 217 of net trades, 166, 171, 217 Allocation matrix, 84 Angular distance function, 245 Arrow-Nerlove theory, 105 Assumptions, xi-xii for competitive equilibrium over time, 241-42, 244, 249-50, 256, 265-66, 274-75, 276–77, 284 in demand theory, 1-2, 6-7, 14, 16, 22, 36, 38 for economy of activities, 77-80 for economy of firms, 70-71, 72, 73-74 for excess demand functions, 46, 48-49, 97 for existence of competitive equilibrium, 191-92, 198, 207, 209, 216, 276 for existence of zero of excess demand functions, 236 for global stability, 90, 95 gross substitute, 49, 66-67, 89, 94, 95, 98-102 for Leontief model with capital coefficients, 293-94, 296, 298 for Pareto optimality, 166, 168, 172, 181 for tâtonnement with trading, 84 for uniqueness of competitive equilibrium, 234 Asymmetric information, markets with, xi Asymptotic cone, 198 Axiom of revealed preference, strong, 38-40Axiom of revealed preference, weak. See Weak Axiom of Revealed Preference Balance condition, 117, 196, 203, 207, 212, 221Balanced collection, 182 Better-point assumption, 6 Binary relation, irreflexive, 215 Bordered Hessian, 17, 18

Bordered substitution matrix, 19

Border's theorem, 182-83, 186, 218 Bounded set, 217 consumption sets, 207 Budget correspondence, open, 202 Budget set, 3, 46, 165, 221 Capital accumulation, 239 beginning of modern theory of, 240 (see also von Neumann model) path(s) of, 244, 250 chaotic, xii convergence of, 240 and turnpike theorems, xii, 53, 281 (see also Turnpike theorems) Capital goods (stocks) in Leontief model, 122-28, 293-99 and maximal sustainable utility, 262 for nonsubstitution theorem, 122 nontrivial optimal stationary, 266 ownership of, 215 sufficient, 266 sustainable, 253, 257, 265, 275 Cauchy-Lipshitz theorem, 93 Certainty equivalent price, 65 Chaotic paths, of capital accumulation, xii Cheaper-point assumption, 7, 8 Cheaper point condition, 101, 207 Choices of consumer, interdependence of, 29 - 30Choquet's theorem, 224 Classical demand theory, 1, 15-22, 46 Classical general equilibrium theory, xi, xii, 239 Cobb-Douglas utility functions, 237 Commodity bundle, 1 assumptions on, 1-2, 7 Commodity space, 215 infinite, 214-29, 239 Comparative statics, 133 global, 143-45 for individual agent, 145-50 and Jacobi's theorem, 157-58 local theory of, 133-40 and local uniqueness of equilibrium, 153-57 and matrices whose roots have negative real parts, 163-64 and maximization under constraint, 161-62 and Morishima case, 140-43 and negative definiteness under constraint, 158 - 61

Comparative statics (cont.) and supermodularity, 150-53 and tâtonnement, 154 Compensated consumer demand, under rationing constraints, 150 Compensated demand correspondence, 8, 10 Compensated demand function, 12, 15, 21, 25 Compensated market demand function, 25 Competitive allocation, 174 in core, 174-75, 181 Competitive equilibrium(a), 221, 277 and core, 171-81 existence of, 183-87, 189 in economy of activities, 189-97, 208, 213-14 in economy of firms, 197-207, 208 with infinite commodity space, 214-29 interiority and irreducibility for, 172, 207 - 14and market demand correspondence, 33 and turnpike theorem, 272, 275-76 and existence of zero excess demand function. 236 and Pareto optimum, 165-71, 174 with redistribution, 166 over time, 239-40 and generalized Ramsey growth model, 248 - 55and generalized Ramsey model with discounting, 259-64 and turnpike theorem, 272-93 and turnpike theorems over infinite horizon, 255-59 and turnpike theorems for quasistationary model, 264-72 and turnpike theorems for von Neumann model, 244-48 and von Neumann model, 240-44 uniqueness of, 229-35 Constraint(s) binding, 146-47 budget, 215 independent, 147 maximization under, 161-62 negative definiteness under, 158-61 rationing, 150 Constraint set, 146 Consumer in demand theory, 1, 3-4 (see also Demand theory)

representative, 239 Consumer choices, interdependence of, 29-30 Consumer demand, under rationing constraints, 150 Consumer sets assumption, 168 Consumption bundles, 13 personal services as, 45 Consumption set, 214 bounded, 207 and trading set, 45 Continuity of minimum income function, 33-34 of $\mu_A(s)$, 129–31 Continuity of preference, assumption of, 166, 168, 172, 178, 181, 184 Core and competitive equilibrium, 171-81 equal treatment, 175, 179, 183, 185, 186, 221 - 23nonemptiness of, 181-83 strong, 180, 181 Correspondence budget, 202 demand, 3, 14, 16, 198 compensated, 8, 10 individual, 192, 193 market, 30, 32, 192 excess demand, 46 market, 46, 47 graph of, 4, 218 indifference, 2 lower section of, 13 lower semicontinuous, 30-31, 200, 261, 292 open budget, 202 open valued, 171 preference, 2, 13-14, 198, 216 strict, 2, 30 supply, 71 upper semicontinuous, 31, 261 Correspondence principle, Samuelson's, 235 Cramer's Rule, 138, 146, 149 Critical value, 156 Current prices, 129 Demand condition, 196, 203, 207, 212, 221 Demand correspondence, 3, 14–15,16, 198 compensated, 8, 10 individual, 192, 193 market, 30, 32-33, 192

market excess, 46, 47

Demand function(s) excess, 45-49, 84, 133, 233 individual. 96-98 market, 28, 60, 74, 96-98 and tâtonnement, 53, 60 zero of, 235-37 group, 40-43 individual, 25-26, 29 market, 25-33, 98 Walrasian, 12, 25 Demand increase, and unit-free stability, 139 - 40Demand theory classical, 1, 15-22, 46 and comparative statics for individual agent, 150 and continuity of minimum income function, 33-34 direct approach to, 1-13 and Euler's theorem, 35 and group demand functions, 40–43 and Law of Demand in relation to risk aversion, 36-38 and market demand function, 25-33 and method of revealed preference, 22-25 and negative semidefiniteness of minimum income function, 34-35 and quasi-linear preferences, 35 and strong axiom of revealed preference, 38 - 40without transitivity, 13-15 Depreciation factor, 123 Dierker theorem, 229, 234 Diewirt's theorem, 96, 98 Discount factors, 239-40 Discounting, generalized Ramsey model with, 259-64 Disposal activities, 50 Dominant diagonal, 50 Duality, proofs by, 120–21 Durable goods, and overlapping generations models, 107 Economic fluctuations, 239 Economy(ies) with excess demand having gross substitute property, 90 irreducible, 172, 191, 208 revealed preference, 143 strongly irreducible, 183, 184, 216 substitutive, 143

Economy of activities, 77-82 existence of competitive equilibrium in, 189-97, 208, 213-14 and Pareto optimality, 165 Economy of firms, 69-77 existence of competitive equilibrium in, 197-207, 208 and Pareto optimality, 165 Edgeworth equilibrium, 231 Efficiency frontier, 70, 77-78, 79 Elasticity of expectations, 64-65, 69 Entrepreneurial factors, 208, 209, 216 Entry of new firms, 77 Environmentalists, and discounting of future utilities, 264 Equal treatment core, 175, 179, 183, 185, 186, 221–23 Equilibrium. See also Competitive equilibrium locally stable, 56 local uniqueness of, 153-57 and Pareto optimality, 165 (see also Pareto optimality) Equilibrium price vector, 50, 143, 155 Equilibrium profit functions, 78 Euler's theorem, 35 Excess demand and gross substitutes assumption, 95 gross substitutes property of, 90 market, 79 negative at zero price, 95 and tâtonnement, 52, 54, 104 Excess demand correspondence, 46 market, 46, 47 Excess demand functions, 45–49, 84, 233 individual, 96-98 market, 28, 60, 74, 96-98 result of shift in, 133 and tâtonnement, 53 local stability of, 60 zero of, 235-37 Excess supply, 95 Exchange economy, 45 and economy of firms, 69 theory of, 45 Existence theorem, assumption of, xi-xii Expansible stock, 250 Expectations assumption of, xii elasticity of, 64-65, 69 and equilibrium over time, 240 extrapolative, 68

Expectations (cont.) and overlapping generations models, 107 rational, 240 with tâtonnement, 64-69, 104 Factor price equalization problem, 232-33 Feasible allocations, 166, 171, 217 Feasible path, 275 Feasible set, 191, 201 Firms economy of, 69-77 existence of competitive equilibrium in, 197-207, 208 and Pareto optimality, 165 entry of, 77 Fixed point theorem(s), 30, 31-32, 196, 203, 207, 262 Foresight, of future prices, xii Free disposal assumption, 16 Frobenius theorem, 114 Future prices, foresight of, xii Gale-Nikaido theorem, 229, 231, 233 General equilibrium theory. See also Competitive equilibrium classical, xi, xii, 239 development of, xi Global comparative statics, 143-45 Global stability, 55-56 with gross substitutes, 89-96, 189, 229 and uniqueness of equilibrium, 229 Graph, of correspondence, 4, 216 Green, Jerry, xi Gross substitute(s), 49 global stability with, 89-96, 189, 229 Morishima case parallel to, 140 and prices (comparative statics), 136-38, 139 Gross substitute assumption, 49, 66-67, 89, 94, 95, 98-102, 143 Gross substitute property, of excess demand, 90 Gross substitution matrix, 20 Group demand functions, 40-43 Hawkins-Simon theorem, 231 Hessian matrix, 17 Hicksian demand function, 12 Hicksian stability, 133, 134 perfect, 134-35, 141-43

Improving coalition, 173, 223 weakly, 180

Income effects, 12 aggregate, 60 Indifference correspondence, 2 Indifference relation, 2 Indirect utility function, 21 Individual demand correspondence, 192, 193 Individual demand function, 25-26, 29 Individual excess demand function, 96-98 Infinite commodity space, 239 existence of competitive equilibrium with, 214 - 29Infinite horizon, turnpike theorems over, 255 - 59Infinite path, 256 optimal, 256, 258 Initial stocks, 45 Insatiability assumption, 46, 191 Interest rates, 129 minimum, 243 Interiority and competitive equilibrium, 172 and existence of competitive equilibrium, 207 - 14Interior point assumption, 46 Inverse demand function, 37 Irreducibility, 172 and competitive equilibrium, 172 and existence of competitive equilibrium, 207 - 14Irreducible economy, 172, 191, 208 strongly, 183, 184, 216 Irreflexive relation, 215 Jacobian matrix, 28, 49, 59, 62-63, 73 and compensated market demand function, 25 and gross substitutes assumption, 229 reduced, 56, 61, 137, 138, 141

Kakutani fixed point theorem, 31–32, 196, 262. *See also* Fixed point theorem

Lagrangian, 162, 237

Law of Demand, 20–21, 27, 37

of supply functions of firms, 81

Jacobi's theorem, 136, 157-58

and risk aversion, 36–38 Le Chatelier theorems of Samuelson, 133, 145

Leontief matrix, 111, 231

Leontief model(s) of production, 109, 244 generalized model, 118

nonsubstitution model with capital stocks, 122 - 28as von Neumann model, 293-99 simple model, 109-14, 122 simple model of growth, 114-18 simple model with variable coefficients, 118 - 22Liapounov function, 87, 91, 268-69, 287 Liapounov theorem, 102 Linear production models, 77, 109 Local better point assumption, 6 Local cheaper point assumption, 7, 8 Local stability of equilibrium, 56 of tâtonnement, 54-64 and Weak Axiom of Revealed Preference, 102 - 104Local theory of comparative statics, 133–40 Local uniqueness of equilibrium, 153-57 Malinvaud economy, 274, 283 Malinvaud model, 249 Marginal utility of wealth, 278 Market(s) with asymmetric information, xi succession of, 83 Market demand, 25, 28, 74 Market demand correspondence, 30, 32-33, 192 Market demand functions, 25-33, 98 Market equilibrium, 50 Market excess demand, 79 Market excess demand correspondence, 46, 47 Market excess demand functions, 74, 96–98 Jacobian of, 28 and local stability of tâtonnement, 60 Market structure, and time, 239 Matrices. See also specific types of matrix decomposable and indecomposable, 56 negative definite, 158-61 negative quasi-definite, 57 P-matrix, 229-31 with quasi-dominant diagonals, 50-52, 111 - 12with roots having negative real parts, 163-64 Maximal discount factor, 245 Maximal expansion factor, 243 Maximal growth rate, 243 Maximal path, 246, 256 Maximization under constraint, 161-62

of utility function, 1 Maximum sustainable utility, 257 Method of Lagrange, see Lagrangian Method of revealed preference, 22-25 Minimum cost approach to demand theory, 21 Minimum income function, 3–7, 42 continuity of, 33-34 negative semidefiniteness of, 34-35 Money, role of, 53 Monotonicity assumptions, 16 Morishima case, 140-43 Negative definiteness, under constraint, 158 - 61Negative real parts, matrices with roots having, 163-64 Negative semidefiniteness, 13 of minimum income function, 34-35 Neighborhood turnpike theorem, 268 for von Neumann facet, 272, 291 Net trades, allocation of, 166, 217 "No free lunch" assumption, 241 Nonsatiation assumptions, 166, 168 Nonsubstitution theorem for Leontief model with capital stocks, 125-26, 127 Nonsubstitution theorem of Samuelson, 119 - 22Nontrivial optimal stationary stock, 268 Norm, 216 Numéraire, 129 choice of, 62 O-balanced, 182 Offer locus, 27 Open budget correspondence, 202 Optimal capital accumulation, macro models of, xii Optimal growth theory, xi, xii Optimality theorem, assumption of, xi-xii Optimal path, 251 infinite, 256, 258 stationary, 256, 264 Output, possible equilibrium, 112 Overcompensated demand function, 23 Overlapping generations models, xii, 107, 239 Pareto improvement, 174 Pareto optimality (optimum), 86-87, 165 and coalition of the whole, 180

and competitive equilibrium, 165–71, 174

Pareto optimality (optimum) (cont.) First Theorem of, 167, 191 Second Theorem of, 168 weak, 180-81 Pareto preferred set, 166 Pareto weakly preferred set, 166 Path feasible, 274 maximal, 246 optimal infinite, 256, 258 Path(s) of capital accumulation, 244, 250 chaotic, xii convergence of, 240 and turnpike theorems, xii, 53, 281 (see also Turnpike theorems) Perfect foresight, xii Physiocrats, 165 P-matrix, 229-31 Possible equilibrium output, 112 Preference(s) quasi-linear, 35-36 strict convexity of (assumption), 46 Preference correspondence, 2, 13–14, 198, 216 strict, 2, 30 Preference relation, 1, 2, 191 strict, 2, 14, 191, 215 Prices, 53 current, 129 present, 129 Price supports, 125 Price tâtonnement. See Tâtonnement Price vector(s), 125 admissible, 223 equilibrium, 50, 143, 155 von Neumann, 298 and Weak Axiom of Revealed Preference, 143 Production. See also Leontief model(s) of production activities model of, 77-82 (see also Economy of activities) firms model of, 69-77 (see also Economy of firms) linearity of, 77 theory of, 1 and Euler's theorem, 35 Production possibility frontier, 70 Production set assumption, 168, 189ff, 198ff, 208, 210-11, 215, 243-44, 273-74 Productivity of labor, different change factors for in different industries, 128 Profit condition, 117, 192, 196, 203, 206, 207, 212, 221, 228

Profit function, 70-71 Proofs by duality, 120-21 Proportional growth programs, 127 Pseudo-Slutsky matrix, 42 Quasi-dominant diagonals, matrices with, 50-52, 111-12 Quasi-equilibrium, with redistribution, 169 Quasi-linear preferences, 35-36 Quasi-stationary model, 259-61 turnpike theorem for, 264-72 Rader's theorem, 77 Ramsey growth model, 240-41 generalized, 248-55 with discounting, 259-64 infinite horizon in, 249, 255 turnpike results in, 264-65, 272 Rational expectations, 240 Rationing constraint, 150 Redistribution competitive equilibrium with, 166 quasi-equilibrium with, 169 Regular value, 17, 19, 156 Relative interior, 173, 208-09 Relatively strictly convex set, 296 Representative consumer, 239 Revealed preference method of, 22-25 strong axiom of, 38-40 weak axiom of, 22-23, 60-62, 96, 100 and gross substitute assumption, 143 and local stability, 102-104 Revealed preference economy, 143 Risk aversion coefficient of, 20 and Law of Demand, 36-38 Roy's identity, 21 Rule of signs, 140 Samuelson's correspondence principle, 235 Scarf theorem, 186, 214-15, 218, 220 Separability, in utility, 274 Set. See also specific types of set bounded, 217-18 consumption set, 207 comprehensive, 220 feasible, 191 relatively strictly convex, 296 Set of admissible price vectors, 221 Signs, rule of, 140 Slater Condition, 217 Slutsky relation, 12, 13, 23, 25-26, 41

in matrix form, 19

316

Smoothness assumption, 16 Social production set, 210-11 Social survival assumption, 172 Social welfare function, 278. See also Welfare function Speculation, 52, 82-83 Stability global, 55-56 with gross substitutes, 89-96, 189, 229 and uniqueness of equilibrium, 229 local linear, 235 problem of, 240 of tâtonnement, 239, 240 local stability, 54-64 in temporary equilibrium model, 104-107 of turnpike property, 53 unit free, 139 Stability theory, assumption in, xii Stationary optimal path, 256, 264 Stationary paths, nontrivial, 266 Stationary stock, nontrivial optimal, 266 Stocks. See Capital goods Strict convexity of preference assumption, 46 Strictly preferred set, 165 Strict preference correspondence, 2 with interdependence, 30 Strict preference relation, 2, 14, 191, 215 Strong axiom of revealed preference, 38-40 Strong core, 180, 181 Strong gross substitute(s), 49 Strong gross substitutes assumption, 49 Strongly irreducible economy, 183, 184, 216 Substitution effect, 12, 27 Substitution matrix, 10, 19 bordered, 19 Substitutive economy, 143 Sufficient capital stock, 266 Supermodularity, and comparative statics, 150 - 53Supply correspondence, 71 Survival assumption, 208 Sustainable stock, 253, 265, 275 Tâtonnement, xii, 52-53 and choice of numéraire, 62-63 and comparative statics, 154 in economy of activities, 78, 79-80, 82 in economy of firms, 74, 76, 77 with expectations, 64-69, 104 and global stability with gross substitutes, 89-96 stability of, 239, 240 local, 54-64

in temporary equilibrium model, 104-107 with trading, 82-89 Temporary equilibrium, theories of, xii Temporary equilibrium model, stability of, 104 - 107Theory of demand. See Demand theory Theory of exchange economy, 45 Theory of Value, The (Debreu), 4 Time, competitive equilibrium over. See under Competitive equilibium Trades allocation of, 168, 171, 217 assumption on efficiency of, 84 and liquidation of assets, 272 Trading, tâtonnement with, 82-89 Trading sets, 190, 192, 200, 211, 214 and consumption sets, 45 Transitive preference orders, 198 Transitivity, demand theory without, 13-15 Turnpike, 243 Turnpike property, 53, 285 for Ramsey model, 264-65 Turnpike theorems, 240 assumptions for, xi-xii in competitive equilibrium, 272-93 and discounting, 259 over infinite horizon, 255-59 neighborhood, 268 for von Neumann facet, 272, 291 and path of capital accumulation, xii, 53, 281 proof of, 252 for quasi-stationary model, 264-72 for von Neumann model, 244-48, 252, 255 Uncertainty and certainty equivalent price, 65 and infinity of goods, 214 in optimal capital accumulation, xii Uniform strict concavity, 259, 265 Unique capital stock, 257 Uniqueness of equilibrium, 153–57, 229–35 Unit free stability, 139 Universal productive factor, 210 Utility in Ramsey model, 249 separability in, 274 Utility function(s) assumption on, 249, 256 Cobb-Douglas, 237 indirect, 21 maximization of, 1, 15 periodwise, 249 Utility weights, 283, 285

V-allocation, 220 Value critical, 156 regular, 156 Value and Capital (Hicks), 1, 64, 69, 197, 214 Value function, 258, 285 Value loss, 252 Vectors, positively linearly independent, 147 von Neumann equilibrium, 294, 296 von Neumann facet, 245, 248, 252, 297-99 convergence to, 259 neighborhood turnpike theorem for, 272, 291 one dimensional, 247 and utility sum achieved, 265 von Neumann model, 109, 116, 117, 240-44 equilibrium of, 241 Leontief model with capital coefficients as, 293-99 objective described in, 250-51 Radner lemma for, 245, 252 turnpike theorem for, 244-48, 252, 255 Walras, Léon and activities model, 77, 78 and classical mechanics, 4 and competitive markets, 171 on optimality, 165 on prices, 53, 70 and role of industrial process, 201 Walrasian demand function, 12, 25 Walras' Law, 46, 49, 74, 96, 193, 236 Weak Axiom of Revealed Preference, 22– 23, 60-62, 96, 100 and gross substitutes assumption, 143 and local stability, 102-104 Weak Pareto optimum, 180-81 Weakly improving coalition, 180 Welfare economics. See also Pareto optimality first theorem of, 168 second theorem of, 170, 189 Welfare function, 278-79, 289 periodwise, 282 and utility weights, 283 Welfare gain, 287 Worst element, 181 Yosida-Hewitt theorem, 227 Zero of excess demand functions, existence of, 235-37